

The Masked Shrew, *Sorex cinereus*  
(Insectivora: Soricidae), and Red-backed Vole,  
*Clethrionomys gapperi* (Rodentia: Muridae), in the  
Blue Ridge Province of South Carolina

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**ABSTRACT**—The first records of *Sorex cinereus* Kerr are documented from South Carolina. Pitfall surveys throughout the Blue Ridge Province resulted in captures from two localities in markedly mesic, relict, boreal habitats. Additional records of *Clethrionomys gapperi* (Vigors) were documented including the most southeastern record. Both *S. cinereus* and *C. gapperi* are rare in South Carolina, largely because of limited areas of appropriate habitats.

The masked shrew, *Sorex cinereus* Kerr, has the largest range and exhibits the greatest geographic variation of any North American *Sorex* (Hall 1981, Junge and Hoffmann 1981, van Zyll de Jong and Kirkland 1989). It ranges throughout the transcontinental coniferous forests from the Canadian Arctic south to the extreme northern portions of the United States with significant extensions south into the

montane forests of the Rocky and Appalachian mountains. In the southeastern United States including Virginia and West Virginia, eastern Kentucky and Tennessee, North Carolina and Georgia, *S. cinereus* is restricted primarily to high elevation montane communities of the Appalachian Highlands (van Zyll de Jong and Kirkland 1989). To date, however, there have been no records from South Carolina (Golley 1966, Mengak et al. 1987).

Previously, the southernmost records of *S. cinereus* have been reported from Georgia based upon three specimens reported by Wharton (1968) from Beech Creek near its confluence with the Talulla River, Towns County, at an elevation of 807 m. More recently, Ford et al. (In press) have reported *S. cinereus* from numerous, widely scattered localities throughout the Blue Ridge Province of Georgia, including localities in close proximity to the South Carolina state line. Similarly, *S. cinereus* has been reported from several Blue Ridge Province counties in North Carolina (Polk, Henderson, Transylvania, Jackson, Macon, and Clay) which are contiguous to South Carolina (Lee et al. 1982 and unpublished University of Georgia, Museum of Natural History records). Because *S. cinereus* is known to occur in immediately adjacent areas of Georgia and North Carolina and because seemingly appropriate areas of high elevation habitat exist in the Blue Ridge Province of South Carolina, we surveyed the mountainous portions of Oconee, Pickens, and Greenville counties specifically for *S. cinereus*.

#### METHODS

From 23 January to 1 May 1994 pitfall trap surveys were conducted throughout the Blue Ridge Province of extreme northwestern South Carolina including, from east to west, portions of Greenville, Pickens, and Oconee counties. We totalled 14,000 trap nights at 17 individual sites. At each site twenty, 32-ounce, plastic containers (14-cm lip diameter and 17-cm depth) were placed below ground level adjacent to forest floor debris including stumps, fallen logs, rocks, etc, for a minimum of 60 days. Approximately 0.14L of preservative was placed in the bottom of each pitfall. General habitat features, including dominant overstory and understory vegetation, aspect, and approximate stand age, of each site were recorded and elevations estimated from topographic maps. Traps were checked on a biweekly basis. Specimens were preserved in alcohol for subsequent reproductive and gut content analysis. Standard body measurements were taken, and skulls were prepared for confirmation of identifica-

tion. All specimens were reposit in the mammal collections of the University of Georgia Museum of Natural History.

## RESULTS AND DISCUSSION

We recovered 15 *S. cinereus* at two of 17 Blue Ridge Province sites. Both *S. cinereus* localities were in the northwestern portion of Oconee County. Seven individuals were recovered from the grounds of the Walhala Fish Hatchery in a hemlock (*Tsuga canadensis*) and rhododendron (*Rhododendron maximum*) streamside community which grades upslope into a yellow poplar (*Liriodendron tulipifera*), mixed oak (*Quercus* spp.), hickory (*Carya* spp.), and white pine (*Pinus strobus*) community. Elevation was approximately 760 m. The second *S. cinereus* locality (eight captures) was approximately 1.3 km east of the Walhala Fish Hatchery site in a moderate to mesic mixed oak and yellow poplar hardwood community at approximately 800 m.

*Sorex cinereus* was the dominant small mammal recovered in the Walhala Fish Hatchery site. Fifteen small mammals were recovered in 1,960 trap nights: seven *S. cinereus*, two *S. fumeus*, one *Sorex hoyi*, one *Blarina brevicauda*, two *Peromyscus maniculatus*, and one *Clethrionomys gapperi*. The recovery of *S. cinereus* was fairly evenly distributed over the trapping period with one or two captured during each sampling period.

At the second site, also with 1,960 trap nights, 12 *S. fumeus*, four *S. hoyi*, two *Peromyscus leucopus*, one *P. maniculatus*, two *Blarina brevicauda*, and one *Clethrionomys gapperi* were captured in addition to the eight *S. cinereus*. Here all the cinereus were captured between 20 March and 3 April; six of which were taken in a single pitfall trap beneath a large, heavily rotted log.

The breadth and intensity of our collection efforts indicate a restricted distribution of *S. cinereus* in South Carolina. *Sorex cinereus* is regarded as having a boreomontane distribution (Junge and Hoffman 1981). In the southern Appalachians it has been documented by Odum (1949), Johnston (1967), Gentry et al. (1968), Linzey and Linzey (1971), Whitaker et al. (1975), and Lee et al. (1982) in western North Carolina; Conaway and Howell (1953), Smith et al. (1974), and Harvey et al. (1991, 1992), in the mountainous regions of eastern Tennessee; and Pagels and Tate (1976), Pagels and Handley (1989), Pagels (1991), Kalko and Handley (1993), and Pagels et al. (1994) in southwestern Virginia. It has not been recorded from elevations below 610 m in southwestern Virginia (Pagels and Handley 1989) or North Carolina (Linzey and Linzey 1971, Lee et al. 1982). Similarly,

in Georgia, *S. cinereus* is restricted to high elevation (790–1,370 m) in markedly mesic habitats with northern affinities (Ford et al. 1994).

Kirkland (1985, 1991) indicated that soricids, in general, are most diverse in regions characterized by cool moist forests, possibly by supporting an abundant, stable, and diverse soil invertebrate fauna upon which shrews depend. Pagels et al. (1994) have shown that the presence of *S. cinereus* was significantly correlated with soil moisture holding capacity and total understory vegetation, and that habitat features that promote shaded, moist habitats were particularly important in relict, boreal forest habitats throughout the southern Appalachians.

Although considerable areas of the Blue Ridge Province in South Carolina meet or exceed the minimum elevations at which *S. cinereus* is found elsewhere in the southern Appalachians, boreomontane habitats are limited there. At the southern limit of the Appalachian Mountains, much of the mountain habitat in South Carolina is characterized by south-facing aspects with more xeric, mixed oak and pine communities. Similar xeric south-facing or ridgeline habitats in Georgia yielded few, if any, *S. cinereus* in recent studies (Ford et al. 1994). In Georgia we encountered *S. cinereus* primarily at very high elevations (over 1200 m) or in rich, moist, streamside communities dominated by hemlock and rhododendron on the Rabun Bald Massif. West of the Little Tennessee River in Georgia, *S. cinereus* is restricted to higher (over 1000 m) elevations, and then they only occur in restricted habitats with marked northern affinities such as those described by Wharton (1968).

Our collection site at the Walhala Fish Hatchery is located in a relatively narrow, steep-walled gorge of the East Fork of the Chattooga River. Wharton (1977) noted that similar streamside forest communities on the Georgia side of the Chattooga were kept cool and moist due to complete shading by the hemlock overstory and rhododendron shrub layer as well as by steep-walled gorges. He noted that such areas were refugia of more typical northern forest communities. The Walhala Fish Hatchery, and its associated upslope northern aspect cove hardwood habitat, might represent a limited finger or refugia in South Carolina for boreal species such as *S. cinereus*. The region of the Walhala Fish Hatchery is one of the few sites in South Carolina that has yielded other small mammals with a typical boreal distribution including *Clethrionomys gapperi* (Pivorun et al. 1984) and *Peromyscus maniculatus*. Other high elevation sites in the Blue Ridge Province including Sassafras Mountain, Jones Gap at Caesar's Head State Park, Saluda Mountain and Hogback Mountain were trapped but yielded no *S. cinereus*. *Peromyscus maniculatus* has

been recorded at many of these sites (Golley 1966), and we recovered several specimens at most of these localities. However, *Clethrionomys gapperi* was not reported beyond the Walhalla Fish Hatchery site until we recovered one in the region of Sassafras Mountain (Pickens County, US Hwy 178, 7.4 m north of State Hwy 11). This is most southeastern record for the species and, like *S. cinereus*, it apparently has a very limited distribution in South Carolina.

**ACKNOWLEDGMENTS**—We appreciate the field assistance of numerous persons including E. Mitchell, J. Kimbrell, N. Lautenschlager, B. Smith, L. Grassman, and S. Chalmers. Collecting activities were conducted under South Carolina Permit #0016-94. We also thank biologists with the Walhalla Fish Hatchery, Sumpter National Forest, and Caesar's Head State Park for permission to conduct surveys on United States Forest Service and South Carolina State Park lands.

#### LITERATURE CITED

- Conaway, C. H., and J. C. Howell. 1953. Observations on the mammals of Johnston and Carter counties, Tennessee and Avery County, Virginia. *Journal of the Tennessee Academy of Science* 28:53-61.
- Ford, W. M., J. Laerm, D. C. Weinand, and K. G. Barker. 1994. Small mammal surveys in the Chatahoochee National Forest of Georgia. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* (In press).
- Gentry, J. B., E. P. Odum, M. Mason, V. Nabholtz, S. Marshall, and J. T. McGinnis. 1968. The effect of altitude and forest manipulation on relative abundance of small mammals. *Journal of Mammalogy* 49:539-541.
- Golley, F. B. 1966. South Carolina mammals. Contributions from the Charleston Museum, Charleston, South Carolina.
- Hall, E. R. 1981. The mammals of North America. Second edition. John Wiley & Sons, New York, New York.
- Harvey, M. J., C. S. Chaney, and M. D. McGimsey. 1991. Distribution, status, and ecology of small mammals of the Cherokee National Forest, Tennessee (Southern Districts). Unpublished manuscript. Center for the Management, Utilization, and Protection of Water Resources, Tennessee Technological University, Cookeville.
- Harvey, M. J., M. D. McGimsey, and C. S. Chaney. 1992. Distribution, status, and ecology of small mammals of the Cherokee National Forest, Tennessee (Northern Districts). Unpublished manuscript. Center for the Management, Utilization, and Protection of Water Resources, Tennessee Technological University, Cookeville.

- Johnston, D. W. 1967. Ecology and distribution of mammals at Highlands, North Carolina. *Journal of the Elisha Mitchell Scientific Society* 83:88-98.
- Junge, J. A., and R. S. Hoffmann. 1981. An annotated key to the long-tailed shrews (genus *Sorex*) of the United States and Canada, with notes on middle American *Sorex*. *Occasional Papers of the Museum of Natural History, University of Kansas* 94:1-48.
- Kalko, E. K. V., and C. O. Handley, Jr. 1993. Comparative studies of small mammal populations with transects of snap traps and pitfall arrays in southwest Virginia. *Virginia Journal of Science* 44:3-18.
- Kirkland, G. L., Jr. 1985. Small mammal communities in temperate North American forests. *Australian Mammalogy* 8:137-144.
- Kirkland, G. L., Jr. 1991. Competition and coexistence in shrews (Insectivora: Soricidae). Pages 15-22 in *The biology of the Soricidae* (J. S. Findley and T. L. Yates, editors). The Museum of Southwestern Biology, Albuquerque, New Mexico.
- Kirkland, G. L., Jr., and P. K. Sheppard. 1994. Proposed standard protocol for pitfall sampling of small mammal communities. Pages 277-281 in *Advances in the biology of shrews* (J. F. Merritt, G. L. Kirkland, Jr., and R. K. Rose, editors). Special Publication, Carnegie Museum of Natural History 18:1-485.
- Lee, D. S., J. B. Funderburg, and M. K. Clark. 1982. A distributional survey of North Carolina mammals. *Occasional Papers of the North Carolina Biological Survey, Raleigh*.
- Linzey, A. V., and D. W. Linzey. 1971. *Mammals of the Great Smoky Mountains National Park*. University of Tennessee Press, Knoxville.
- Mengak, M. T., D. C. Guynn, Jr., J. K. Edwards, D. L. Sanders, and S. M. Miller. 1987. Abundance and distribution of shrews in western South Carolina. *Brimleyana* 13:63-66.
- Odum, E. P. 1949. Small mammals of the Highlands (North Carolina) Plateau. *Journal of Mammalogy* 30:179-192.
- Pagels, J. F. 1987. The pygmy shrew, rock shrew and water shrew: Virginia's rarest shrews (Mammalia: Soricidae). *Virginia Journal of Science* 38:364-368.
- Pagels, J. F. 1991. A high elevation record for the least shrew, *Cryptotis parva* (Say). *Virginia Journal of Science* 42:361-362.
- Pagels, J. F., and C. O. Handley, Jr. 1989. Distribution of the southeastern shrew, *Sorex longirostris* Bachman, in western Virginia. *Brimleyana* 15:123-131.
- Pagels, J. F., and C. M. Tate. 1976. Shrews (Insectivora: Soricidae) of the Paddy Knob-Little Back Creek Area of western Virginia. *Virginia Journal of Science* 27:202-203.

- Pagels, J. F., K. L. Uthus, and H. E. Duval. 1994. The masked shrew, *Sorex cinereus*, in a relictual habitat of the southern Appalachians. Pages 103–109 in *Advances in the biology of shrews* (J. F. Merritt, G. L. Kirkland, Jr., and R. K. Rose, editors). Special publication, Carnegie Museum of Natural History 18:1–485.
- Pivorun, E. B., D. H. Allen, and D. T. Sawyer. 1984. First record of *Clethrionomys gapperi* (Mammalia: Rodentia) in South Carolina. *Journal of the Elisha Mitchell Society* 100:33.
- Smith, C. R., J. Giles, and M. E. Richmond. 1976. The mammals of northeastern Tennessee. *Journal of the Tennessee Academy of Science* 49:88–94.
- van Zyll de Jong, C. G., and G. L. Kirkland, Jr. 1989. A morphometric analysis of the *Sorex cinereus* group in central and eastern North America. *Journal of Mammalogy* 70:110–122.
- Wharton, C. H. 1968. First records of *Microsorex hoyi* and *Sorex cinereus* from Georgia. *Journal of Mammalogy* 49:158.
- Wharton, C. H. 1977. The natural environments of Georgia. Georgia Department of Natural Resources, Office of Planning and Resources, Atlanta.
- Whitaker, J. O., Jr., G. S. Jones, and D. D. Pascal. 1975. Notes on mammals of the Fires Creek Area, Nantahala Mountains, North Carolina, including their parasites. *Journal of the Elisha Mitchell Scientific Society* 91:13–17.

*Received 25 July 1994*

*Accepted 30 November 1994*